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Method of transporting electrical energy

The invention concerns an apparatus for and a method of transporting electrical energy. Electrical conductors are used almost without exception as such apparatuses. However those electrical conductors are only limitedly suitable for transport over relatively long distances as the losses in such conductors rise with increasing length and make energy transport when long distances are involved uneconomical.

Alternatively electrical energy is used to perform a chemical process such as electrolysis which results in a desired substance such as for example hydrogen. That substance can be transported to a destination and there converted into electrical energy again by a suitable apparatus such as for example a fuel cell. That situation however involves transporting not electrical energy but an energy carrier, the production of which on the one hand and the conversion into electrical energy of which on the other hand involves losses.

In addition it has long been known for electrical energy which is required for the operation of apparatuses to be carried on or in such apparatuses in suitable storage devices. By way of example reference may be made here to a motor vehicle which includes a lead accumulator which provides the electrical energy required for the start-up process. A further example is for example mobile telephones which are provided with accumulators for providing the energy required for operation thereof. Those examples however always involve suitably carrying around energy which is required by the unit itself.

In accordance with the invention, it is here precisely not the storage device which makes the energy available in the case of portable units, but transport of the energy as such, in particular over long distances, that is meant.

In comparison therewith the object of the present invention is to provide an apparatus for and a method of transporting electrical energy

with the lowest possible level of losses over long distances so that the energy is ready at the destination for consumption outside the vehicle.

In an apparatus of the kind set forth in the opening part of this specification that object is attained by a storage device which is formed from a plurality of storage elements and which is arranged as a payload on and/or in a vehicle or craft, wherein in the delivery of the electrical energy the storage device remains on and/or in the vehicle and the vehicle has a connection for transmitting the stored electrical energy upon discharge.

In addition that object is attained by a method comprising the following steps:

- charging the storage device with electrical energy;
- transporting the vehicle to a destination; and
- discharging the storage device at the destination.

In that respect the invention is based on the realisation that such storage devices admittedly always involve a mass which, in the case of a lead accumulator, is considerable, but that this disadvantage fades into the background in the case of transport over very long distances with a correspondingly large-size transport capacity, in comparison with the possible ways of transporting a very large amount of energy in the form of electrical energy by way of conductors and the losses that this entails.

In a preferred embodiment of the invention accumulators and/or capacitors are provided as storage elements. These are common storage elements and are also available in large numbers. In addition use in the event of damage is thus reliably possible.

In a particularly preferred feature a plurality of storage elements are combined together mechanically and/or electrically to form storage device groups. By virtue of that combination, on the one hand they can be charged or discharged at the same time and/or in the case of replacement they can be handled as a complete group without each storage element having to be handled individually. That is particularly advantageous if the storage device comprises a very large number of storage elements so that access to an individual storage element is very complicated and expensive. In this case a storage device group in which the storage element which is

being sought is included can be rapidly removed from the storage device and replaced by a new, faultless storage device group. The vehicle can then complete its journey with at worst a slight delay.

In a preferred development of the invention the vehicle drive can be operated with the stored energy. This means that there is no need for the vehicle to also carry an additional storage device, for example in the form of a tank with fuel. It will be appreciated that nonetheless a limited supply of fuel and an internal combustion engine can be carried along in order to permit an emergency drive.

In order to permit speedy charging or discharging of a storage device according to the invention, there are preferably provided fixed stations at which intermediate storage devices are arranged. Thus a vehicle can firstly deliver its charge to that intermediate storage device and immediately leave the station again in order to pick up further charges. Then, as required, the energy can be forwarded from the station or the intermediate storage device and fed into a network.

In a preferred embodiment of the invention there can be provided a collective connection for a plurality of storage elements and/or storage device groups. In that way, a plurality of storage elements or storage device groups can be simultaneously charged/discharged, in which case it is possible to save on the time for making the electrical connections to each individual storage element.

In particular if accumulators which contain an electrolyte fluid are used as the storage elements, it is possible to save on a considerable part of the weight of the storage device by removing the fluid so that the fluid is not contained in the accumulators during the transport procedure. For that purpose each storage element preferably has an opening. In that way, the required drive power is reduced or, if the carrying capacity of the vehicle is fully utilised, the amount of energy which can be transported is increased.

In order not to have to drain off the fluid separately at each individual storage element, the openings of a plurality of storage elements can be connected together by collecting conduits. That also affords a time saving when filling or draining off the fluid.

If, when draining off the fluid, the fluid is firstly collected in a container on board the vehicle, that fluid, after having been drained out of the storage elements, can be taken off the vehicle with that container in one working operation or, prior to filling of the storage elements, the fluid can be put on board in one working operation and preliminary treatment procedures or subsequent treatment procedures can be carried out independently of the vehicle and without influencing the travel schedule thereof. If the vehicle for transporting a battery storage device is for example a ship, then that ship can already cast off, after charging of the storage device, and begin the journey to the destination port, while the electrolyte is being drained out of the batteries and collected in a container (or a plurality of containers).

As soon as the electrolyte is drained out of all storage elements, that container can be transferred for example with an on-board loading apparatus on to another ship which carries the fluid back to land for preparation and storage. With suitable container sizes, that task can also be performed by an aircraft such as for example a helicopter.

A preliminary treatment or a subsequent treatment can involve for example cleaning the fluid in order to remove suspended substances therein. In that way accumulators are always filled with a clean electrolyte and the sludge which with an increasing service life limits the accumulators or the efficiency thereof cannot become deposited. That increases the service life of the storage elements, with a high capacity.

Advantageous embodiments of the invention are set forth in the appendant claims.

An embodiment by way of example of the invention is described in greater detail hereinafter with reference to the drawings in which:

Figure 1 shows a storage device according to the invention on board a ship,

Figure 2 shows an embodiment of a storage device group according to the invention, and

Figure 3 shows a simplified view of the procedure involved in energy transport according to the invention.

Figure 1 shows a ship 10 as a transport vehicle or craft for a storage device according to the invention. That storage device is made up of a plurality of storage elements which are combined together in grouped relationship in containers 12. The containers 12 can be for example commercially usual containers which can be transported on known and available container ships, both below deck, in cargo spaces and also as deck load. In that way considerable amounts of storage devices can be transported with such a ship 10.

In order to charge up or discharge the storage devices it is sufficient to provide a suitable connection at the outside of each container 12. If storage elements should turn out to be defective, the container 12 in question with the defective storage device can be unloaded and replaced by a substitute container using standard loading equipment such as container bridges or container spreaders, so that the turnaround time of the ship is not prolonged to any degree worth mentioning, even if storage elements have to be replaced. In a corresponding manner for example when using accumulators as the storage elements, the electrolyte fluids can be respectively introduced and drained off in container-wise fashion in each case by way of collecting conduits in order in that way to reduce the weight of the storage device during the journey.

Figure 2 shows a partially cut-open view of such a container 12 with storage elements 14 arranged therein in such a way as to fill up the space. In the left-hand part of Figure 2 the storage elements 14 are shown in the form of capacitors such as for example high-capacity ultracaps. In the right-hand part of the Figure they are shown in the form of accumulators, for example lead accumulators. That clearly shows the many different possible ways of constructing the storage device. It will be appreciated that basically it is possible to use any suitable storage elements 14.

Figure 3 shows the method according to the invention. The left-hand part of the Figure shows wind power installations 20 which continuously generate electrical energy. That electrical energy is stored in an intermediate storage device 24 by way of a control 22. If now a ship 10 or the storage devices thereof are to be charged up the storage devices are

connected to the connecting station 26 and the control 20 causes a flow of current from the intermediate storage device 24 and/or the wind power installations 20 to the connecting station 26 and to the storage device on board the ship 10.

As soon as the storage device on board the ship 10 is charged up, then, in the case of lead accumulators, the electrolyte can be drained off and cleaned and then stored in a tank. The ship 10, with the charged storage devices but without electrolyte, can then steer for its destination port. There it is once again connected to a connecting station 36. If necessary electrolyte which is stored there can again be filled into the lead accumulators and the discharge operation begins. In that case there is once again provided a control 32 which firstly causes a flow of current from the storage device into an intermediate storage device 34 and/or straightaway into a network 30 in which the electrical energy can then be consumed.

For the return journey the electrolyte can then be removed again from the storage device which has been discharged in the meantime.